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EXAMINER

MOHAMEDULLA, SALEHA R

ART UNIT PAPER NUMBER

1756

DATE MAILED: 09/25/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application N .

09/917,697

Applicant(s)

DULMAN ET AL.

Examiner

Saleha R. Mohamedulla

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 7/31/01 and 3/13/03.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-48 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 12-22 is/are allowed.
- 6) ☒ Claim(s) 1-11, 23-26, 28-39, 47 and 48 is/are rejected.
- 7) ☒ Claim(s) 27 and 40-46 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 01 October 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 3.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Claims 1-48 are pending.

Information Disclosure Statement

1. The references listed in the Non-Patent Literature Documents section of the IDS filed in Paper No. 3, March 13, 2003, are crossed out as the dates of the references are missing from both the listing and the references. The examiner cannot determine whether or not the references are prior art. The examiner requests that Applicant supply the dates and page numbers of the references.

Drawings

2. The formal drawings, which were filed on October 1, 2001, are acceptable.

Specification

3. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

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5. Claims 11 and 32-36 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

6. Claim 11 recites the limitation "said transparent opening" in line 2. There is insufficient antecedent basis for this limitation in the claim.

7. Claim 32 recites the limitation "said bars" in line 2. There is insufficient antecedent basis for this limitation in the claim. Claim 31, from which claim 32 depends, only recites bar-shaped assist features.

8. Claim 33 recites the limitation "said layer of transparent material " in line 4. There is insufficient antecedent basis for this limitation in the claim. Claims 34-36 are rejected as being dependent on claim 33.

Claim Rejections - 35 USC § 102

9. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

10. Claims 28-30 are rejected under 35 U.S.C. 102(e) as being anticipated by US# 6,294,295 to Lin et al.

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Lin teaches a phase shifting mask to compensate for side lobe problems. Lin teaches that the mask is formed on a transparent substrate, such as quartz. A patterned layer of first attenuating phase shifting material provides a 180 degree phase shift. The transmittance is about 5% to 7% and the material is MoSiON, which refers to attenuating materials such as molybdenum silicide, molybdenum silicon oxide, or molybdenum silicon oxynitride. A patterned layer of opaque, or light-obstructing, material defines rims 119, as shown in Figures 4 and 5 (col. 4, lines 25-45). The opaque layer is made of chrome. The opaque chrome layer also defines second rims 121 of second attenuating phase shifting material surrounding each of the second holes 120. The transmittance of the attenuating phase shifting material can also be around 10 to 20% (col. 2, lines 44-53). Therefore, Lin teaches a layer of transparent material, a layer of light-obstructing material, and a layer of attenuating phase shifting material located between the layer of transparent material and the layer of light-obstructing material. Figures 4 and 5 show that these layers are patterned to form transparent holes 118. The figures also show light obstructing frames or rims 119 and 121 that surround the transparent holes. These frames or rims have a transmittance of 5-7% or 10-20%, so they are light-obstructing or partially transparent. In addition, that opaque background can also be construed as a frame. Therefore, Lin teaches the limitations of claim 28. As shown in Figure 4, the contact-hole-with-partially-transparent-frame features in the middle and in the corners are surrounded by other contact hole features that also have partially transmissive frames. These partially transmissive frames are covered by opaque patterns, as shown in Figure 5. The opaque patterns have corners. Therefore, Lin teaches the limitations of claims 29 and 30.

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11. Claims 37-39 and 47 are rejected under 35 U.S.C. 102(b) as being anticipated by US# 5,447,810 to Chen et al.

Chen teaches forming scattering bars to prevent optical proximity effects. Proximity effect adjustments depend on the width of the bar and the distance that the bar is disposed from the feature edge (col. 4, lines 3-6). Chen teaches designing the scattering bars by first selecting an optimal separation distance between the scattering bar and the isolated edge. Then, the optimal width of the scattering bar is selected while utilizing the selected optimal separation (col. 4, lines 22-30). Chen teaches that optimal separation is determined by empirical methods (col. 6, lines 53-55). Once it is determined, the width is selected. Table 2 shows measured critical dimensions at different defocus settings for varying scattering bar widths (col. 8, lines 65-70). Therefore, Chen teaches providing sets of dimension data representative of mask patterns. The table shows features A, C and D with the scattering bars. Because the dimension data is measured for various defocus settings, Chen teaches that for each set of dimension data, calculating feature dimension data as a function of optical conditions (as the defocus setting is an optical condition). Chen teaches that the criteria for an acceptable bottom critical dimension (CD) is $\pm 10\%$ of the target CD and an acceptable top CD is $1/3$ of the target CD (col. 9, lines 10-20). The CD measurement for feature C at a defocus of -1.5 microns was not in an acceptable range, so no CD measurement was given in the table. CD measurements that are acceptable are given in the table. Therefore, Chen teaches for a desired optical condition, the sets of dimension data are identified that have feature dimension data within desired limits. In addition, Chen teaches that from these determinations, an optimum separation of a scattering bar from a feature edge is determined to be 90% of the critical dimension with a width of 0.2 microns (col. 9, lines

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63-70). Therefore, Chen teaches claim 38 and 39 limitations. In figure 8, Chen teaches that the scattering bars each have four corners, which form corners in the opaque background.

Therefore, Chen teaches that the dimension data defines opaque corner structures.

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

13. Claims 1-11, 23-26 and 31-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over US# 6,294,295 to Lin et al. in view of US#5,447,810 to Chen et al.

Lin teaches the limitations discussed above in paragraph 10. The contact hole as shown in Figure 4 is a rectangle. The opaque chrome layer is located above the partially transmissive or light obstructing frame or rim, therefore, Lin teaches that the light-obstructing frame includes an opaque frame that surrounds the transparent hole.

Lin does not teach that the mask has a partially transmissive assist feature or that the light obstructing frame is located between the transparent hole and assist feature. Chen teaches a mask providing increased depths of focus and minimal CD differences by using a mask with anti-scattering bars. In Figure 8, Chen teaches contacts D and E each having an anti-scattering bar (col. 11, lines 40-45). The anti-scattering bar has the same transparency as the contact, that is, they both allow light to pass through during exposure. The shaded area on the mask represents the opacity on the mask. The anti-scattering bars are non-resolvable, and therefore,

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sub-resolution (col. 11, lines 50-55). Therefore, Chen teaches a transmissive assist feature, i.e., the anti-scattering bar. As shown in Figure 8, Chen teaches that the anti-scattering bars 215 and 216 each surround an opaque frame. The opaque frame surrounds the contact hole. Therefore, Chen teaches a light-obstructing frame located between the transparent hole and assist feature. The assist feature is a frame that surrounds the opaque frame, therefore, Chen teaches claim 4 limitations. Also, as shown in Figure 8, Chen teaches the claim 5 limitations that the opaque frame is made of opaque material that forms a background that surrounds the assist frame. When scattering bar 216 is construed as a transmissive assist feature, scattering bar 215 is a further transmissive frame. An opaque frame is located between the contact hole D and bar 215. Chen teaches opaque and transparent features, while Lin teaches opaque, transparent, and attenuating layers. The additional attenuating layer of Lin will cause the bars 215 and 216 to be partially transmissive, instead of transmissive. Also, the attenuating layer of Lin will be located between the bars 215 and 216 and the holes D and E. Therefore, the limitations of claim 11 are met.

Claim 23 adds the limitation that opaque corners are located between the sub-resolution bars. The mask of Chen includes an opaque background. The scattering bars each have four corners, which form corners in the opaque background. Therefore, Chen teaches opaque corners located between sub-resolution bars 215 and 216.

Because the additional attenuating layer of Lin will cause the bars of Chen to be partially transmissive, the claim 31 limitation drawn to the attenuating phase shifting layer defining sub-resolution features is met. The second layer of Lin is chrome and opaque, and therefore prevents light from propagating through the attenuating layer. Chen teaches that an opaque background or frame surrounds the sub-resolution bars 215 and 216. This opaque layer also defines the sub-

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resolution bars 215 and 216, which can also be construed to be the bar-shaped assist features of claim 31. Because the openings in claim 31 are construed to also be the bars, light passing through the openings is the same light passing through the bars. The light operatively interacts with itself because the light rays are passing through the same opening. Therefore, the limitations of claims 31 and 32 are met. Placing bars 215 and 216 of Chen around the hole 118 and frame 119 forms an opaque frame. Therefore, the limitations of claim 33 are met. The rectangular openings in claim 34 can be construed to be some of the transparent holes. That is, the transparent holes can be construed to be the three holes 118 in the second column of all the holes in Lin. The array of rectangular openings in claim 34 can be construed to be the holes in the first and third columns. Since bars 215 and 216 surrounding the holes in the second column will be between the rectangular openings in the first and third columns, the limitations of claim 34 are met. The surrounding opaque background is a patterned layer of opaque material for defining the bars, therefore, the limitations of claim 35 and 36 are met.

The references are analogous art as they are drawn to masks with contact hole patterns. It would have been obvious to one of ordinary skill in the art to include the transmissive assist features of Chen into the mask of Lin in order to increase intensity levels to achieve optimal depth of focus ranges (Chen, col. 11, lines 30-35). One of ordinary skill in the art would have a reasonable expectation of success as Chen is drawn to improved exposure of contact hole pattern masks and the mask of Lin is a contact hole pattern mask. It would be obvious to one of ordinary skill in the art to make the transmissive assist features or frames of Chen partially transmissive assist features or frames in Lin as Lin teaches an attenuating (partially transmissive) phase shifting layer as well as opaque and transparent layers, while Chen's mask only includes

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opaque and transparent features. The assist features or frames will be attenuating assist features and attenuating material will be located between the holes and assist features or frames, because of the additional attenuating layer in Lin.

14. Claim 48 is rejected under 35 U.S.C. 103(a) as being unpatentable over US#5,447,810 to Chen et al. in view of US# 6,294,295 to Lin et al.

Chen teaches the limitations discussed above in paragraph 11. In figure 8, Chen teaches that the transparent scattering bars each have four corners (col. 11, lines 50-55). Chen teaches transmissive corner structures, but does not teach partially transmissive corner structures.

Lin teaches an attenuating rim type phase shifting mask with transparent, attenuating and phase shifting layers as shown in figures 4 and 5 (col. 4, lines 25-45). Lin teaches that frames 119 are made of an attenuating material. The frames 119 each have four corners. Therefore, Lin teaches that the features define partially transmissive corner structures.

The references are analogous art as they are drawn to masks with contact hole patterns. It would have been obvious to one of ordinary skill in the art to use the scattering bars and scattering bar calculation method of Chen when making the mask of Lin in order to increase intensity levels to achieve optimal depth of focus ranges (Chen, col. 11, lines 30-35). One of ordinary skill in the art would have a reasonable expectation of success as Chen is drawn to improved exposure of contact hole pattern masks and the mask of Lin is a contact hole pattern mask. It would be obvious to one of ordinary skill in the art that the resulting mask would have partially transmissive cornered features as the mask of Lin has these features.

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Allowable Subject Matter

15. Claims 12-22 are allowed.
16. Claims 27 and 40-46 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.
17. The prior art does not teach or suggest sub-resolution assist features that prevent incident light from propagating through portions of the attenuating phase shifting material. The assist features in the prior art are transparent and there is no motivation in the prior art to form the assist features to prevent incident light from propagating through the attenuating material. There is also no suggestion in the prior art that shaded serifs (sub-resolution assist features) would work in rim type attenuating contact hole masks. The prior art does not teach or suggest that the mask further comprises partially transmissive bars that surround an opaque frame that surrounds the sub-resolution bars of claim 23. The prior art also does not teach or suggest that the dimension data of claim 39 includes sub-resolution data of opaque features. The prior art teaches or suggests partially transmissive or transmissive sub-resolution features, but does not teach sub-resolution dimensions of opaque features of the patterns of claim 39. The opaque features in the prior art are not sub-resolution and there is no suggestion in the prior art that the masks would function if the opaque features were sub-resolution.

Conclusion

18. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Saleha Mohamedulla whose telephone number is (703) 308-1260. The Examiner can normally be reached Monday-Friday, from 8:00 AM to 4:30 PM. If

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attempts to reach the Examiner by telephone are unsuccessful, the Examiner's supervisor, Mark Huff, can be reached on (703) 308-2464. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9310. The After Final fax phone number is (703) 872-9311. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.



Saleha R. Mohamedulla

Patent Examiner

Technology Center 1700

September 8, 2003